

## A new species of *Kristensenia* Por, 1983 and a new record and illustrated supplementary description of *Halicyclops hurlberti* Rocha, 1991 from Mexico

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### Abstract

A number of harpacticoid and cyclopoid copepods were collected during two short-term studies examining the effects of organic enrichment on the distribution and density of meiofauna in two coastal systems in central (Ensenada del Pabellón lagoon) and southern (Urias system) Sinaloa, north-western Mexico. Harpacticoids were by far the most common Copepoda, followed by cyclopoids and poecilostomatoids. The present contribution provides the complete description of a new species of the so far monotypic genus *Kristensenia* Por, 1983, known from Bonaire (Netherlands Antilles) and Celestún lagoon (Yucatán, Mexico), and the first record and range extension of *Halicyclops hurlberti* Rocha, 1991, previously known from Tihuana estuary near San Diego (California, USA). An updated generic diagnosis for *Kristensenia* Por, 1983 is presented.

**Keywords:** *Copepoda*, *Harpacticoida*, *Cyclopoida*, taxonomy, Mexico

### Introduction

Por (1983) created the genus *Kristensenia* Por, 1983 to accommodate a darcythompsoniuid copepod found in scrapings of decomposing mangrove leaves and detritus from Bonaire (Netherlands Antilles). Por's (1983) original generic diagnosis is very brief and incomplete (it is based on the description of the male only) and no mention is made about the sexual dimorphism. Therefore, an updated diagnosis for the genus is presented here. Despite the fact that *Kristensenia* is defined by a set of characters that place this taxon within the Darcythompsoniidae Lang, 1936 (see Por 1983), this genus is unique within the family mainly because of the lack of sexual dimorphism in the second endopodal segment of P2, caudal rami and anal operculum, and lack of the fan-shaped dorsal organ on the second and third male urosomites (Gómez 2000). *Kristensenia pallida* Por, 1983 was originally described from a single male (only three immature females were found in the samples from Bonaire) and Por (1983) suggested the possibility of some dimorphism in the armature of the endopod of P3, and in the general structure and armature formula of P5. *Kristensenia*

*pallida* was found also in sediment samples from Celestún lagoon (Yucatán, Mexico) (see Fiers 1995: 302) but a redescription of the species and/or comments on its sexual dimorphism is not available yet. The discovery of mature females of the new species described herein from Uriás system (Sinaloa, north-western Mexico) enables us to verify the potential dimorphism suggested by Por (1983: 145).

*Halicyclops hurlberti* Rocha, 1991 was described from material collected in experimental tanks at San Diego University, which contained water collected in the Tihuana estuary. To the best of our knowledge, this is the second record of the species and constitutes a range extension from Tihuana estuary to the mouth of the Gulf of California.

## Material and methods

Triplicate sediment samples were taken during two short-term studies in Ensenada del Pabellón lagoon (central Sinaloa) and Uriás system (southern Sinaloa) using a plastic corer of 7 cm<sup>2</sup> and 9 cm length. The cores taken in Ensenada del Pabellón lagoon were treated as in Gómez-Noguera and Hendrickx (1997). The sediment cores taken from Uriás system were subdivided into five sections of 1.5 cm (10.5 cm<sup>3</sup> each). The subsamples were fixed with 10% formalin, and macro- and meiofauna were then separated using 500 and 63 µm sieves. The meiofauna was preserved in 70% alcohol and copepods were picked out, counted and separated using a stereomicroscope at a magnification of 40×. Observations and drawings were made from whole and dissected specimens using a Leica DMLB microscope equipped with a drawing tube. The type and examined material were deposited in the collection of the Mazatlán Marine Station of the Institute of Marine Sciences and Limnology (National Autonomous University of Mexico). The terminology proposed by Huys and Boxshall (1991) was adopted. The following abbreviations are used in the text, figures and table: A1, antennule; P1–P6, first to sixth leg; EXP, exopod; ENP, endopod.

## Systematic account

### Order HARPACTICOIDA Sars, 1903

### Family DARCYTHOMPSONIIDAE Lang, 1936

### Genus *Kristensenia* Por, 1983

*Diagnosis* (amended). Darcythompsoniidae. Vermiform. Body somites of about the same length, except for cephalothorax and anal somite which are longest. Rostrum not fused to the cephalothorax; with pointed tip. Female antennule six-segmented, with bare setae only; with aesthetasc on fourth segment. Antenna with allobasis; exopod one-segmented and armed with one element. Mandibular palp two-segmented; basis with one element; endopod with four or five setae; without exopod. Maxillule without division between basis, endo- and exopod; basis with three or four setae; endopod and exopod with two setae each. Maxilla with two endites; proximal endite with one, distal endite with two setae; endopod with three elements. Maxilliped subchelate. P1–P4 exopod three-segmented. P1–P4 endopod two-segmented. Outer seta of basis of P1 and P2 spine-like, of P3–P4 seta-like. Armature formula of P1–P4 (EXP/ENP): (P1) I-0; I-0; II, 2, 0/0-0; I, I1, 0; (P2) I-0; I-1; II, 2, 0/0-0; I, 2, 0; (P3) I-0; I-1; II, 2, 1/0-0; I, 2, I; (P4) I-0; I-1; II, 2, 1/0-0; I, 2, I. Female P5 without exopod; baseopod armed with seven elements. Female caudal ramus with concave inner lateral contour; with seven setae. Sexual dimorphism observed in male

antennule (six-segmented; subchirocer; with geniculation in third segment); inner spine of basis, P5 (with five elements), P6 (with two elements) and caudal ramus (inner lateral concave contour even in male, rather uneven in female).

The genus can be separated from *Pabellonia* Gómez, 2000 and *Darcythompsonia* T. Scott, 1906 by (1) the general shape of the maxilliped (subchelate in *Kristensenia*, and of a different shape in *Pabellonia* and *Darcythompsonia*; Gómez (2002: 516) erroneously stated that the maxilliped of *Pabellonia* was like that in *Kristensenia*); (2) shape of anal operculum (with spinular ornamentation, without sexual dimorphism and not upwardly directed in *Kristensenia*; with spinular ornamentation, without sexual dimorphism, but upwardly directed in *Pabellonia*; without spinular ornamentation and strongly sexually dimorphic in *Darcythompsonia*); (3) male P2 endopod (sexually dimorphic in *Pabellonia* and *Darcythompsonia*; without sexual dimorphism in *Kristensenia*); (4) shape, armature and sexual dimorphism of caudal ramus (*Kristensenia* possesses a female caudal ramus with straight and concave outer and inner margin, respectively, broader at its base, about 1.8 times longer than broad, with seven elements, and with the only slight sexual dimorphism being the inner lateral contour of male caudal ramus more even than that of the female; the caudal ramus of *Pabellonia* is about twice as long as broad, with convex and slightly concave inner and outer margin, respectively, with inner distal corner protruded into an extension upwardly directed, with five elements only, and without sexual dimorphism; the caudal ramus of *Darcythompsonia* is similar to that of *Kristensenia*, except for length/width ratio (1.8 in *Kristensenia* and less than 1 in *Darcythompsonia*), and sexual dimorphism in the male caudal ramus of *Darcythompsonia* which is rather cylindrical. *Pabellonia* and *Kristensenia* can be separated from *Darcythompsonia* by the sexually dimorphic fan-shaped organ on the second and third male urosomites (present in the latter, absent in the two former species). On the other hand, *Darcythompsonia* and *Kristensenia* can be separated from *Pabellonia* by the P5 and P6 (present in both sexes in the two former species, but absent in both sexes in *Pabellonia*).

***Kristensenia secunda* Gómez sp. nov.**

(Figures 1–7)

*Type material.* One female holotype (EMUCOP-090301-185), one male allotype (EMUCOP-090301-31) and one male paratype (EMUCOP-090301-169) preserved in alcohol, and two male (EMUCOP-090301-187; EMUCOP-090301-188) and one female (EMUCOP-090301-186) dissected paratypes; collected on 9 March 2001; sandy and silty sediments; 0–3 cm deep into the sediment. Coll. Samuel Gómez.

*Type locality.* Uriás system, Sinaloa (23°11'06"N, 106°25'06"W), north-western Mexico.

*Etymology.* The specific name makes reference to the fact that this is the second species of the genus *Kristensenia* reported so far.

*Description*

*Female.* Body (Figure 1A, B) elongate, nearly cylindrical, tapering slightly from first urosomite to distal portion of anal somite; dorsal and ventral surface smooth.

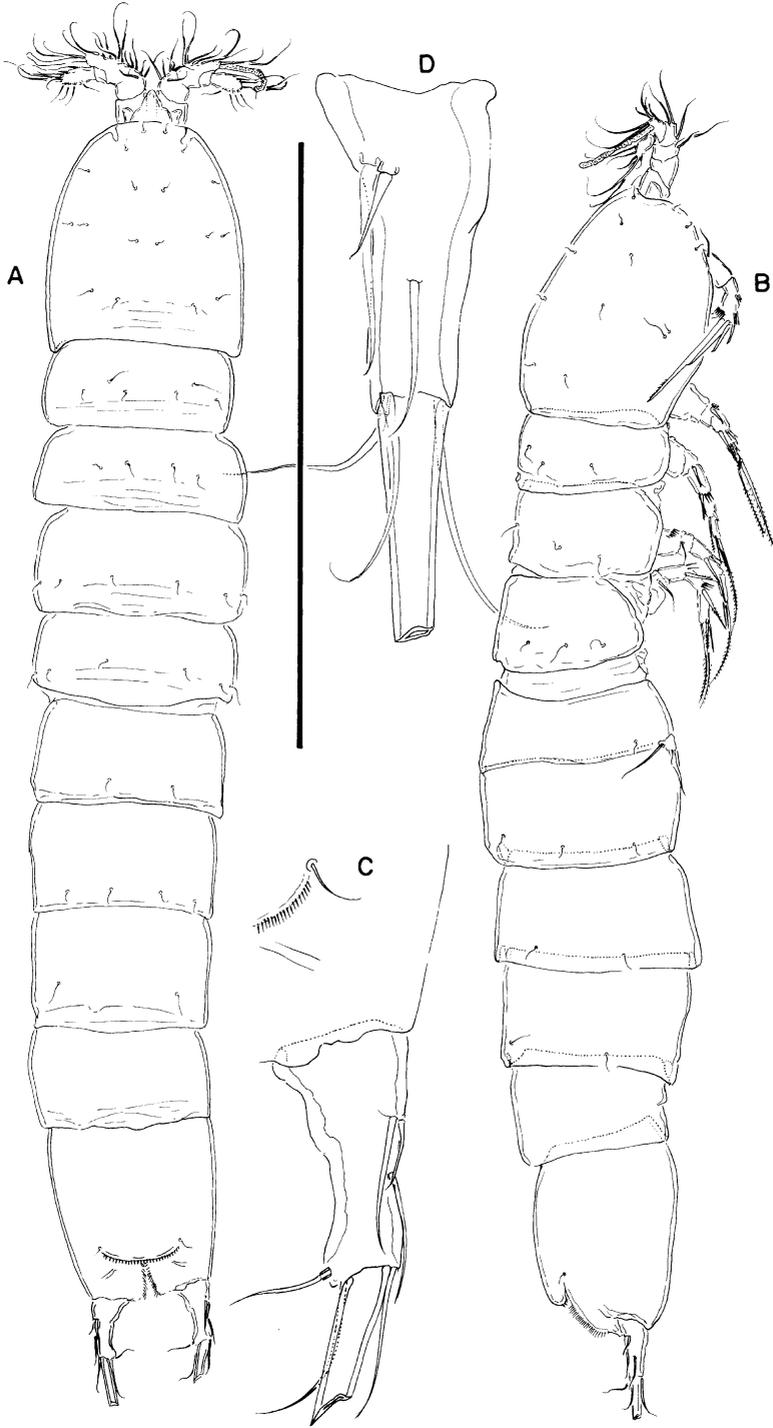


Figure 1. *Kristensenia secunda* Gómez sp. nov., female. (A) Habitus, dorsal; (B) habitus, right lateral; (C) right caudal ramus, dorsal; (D) right caudal ramus, lateral. Scale bar: 500  $\mu\text{m}$  (A, B); 22  $\mu\text{m}$  (C); 87  $\mu\text{m}$  (D).



Figure 2. *Kristensenia secunda* Gómez sp. nov., female. (A) Antennule and rostrum, ventral; (B) antenna; (C) mandible. Scale bar: 71  $\mu\text{m}$  (A); 50  $\mu\text{m}$  (B, C).

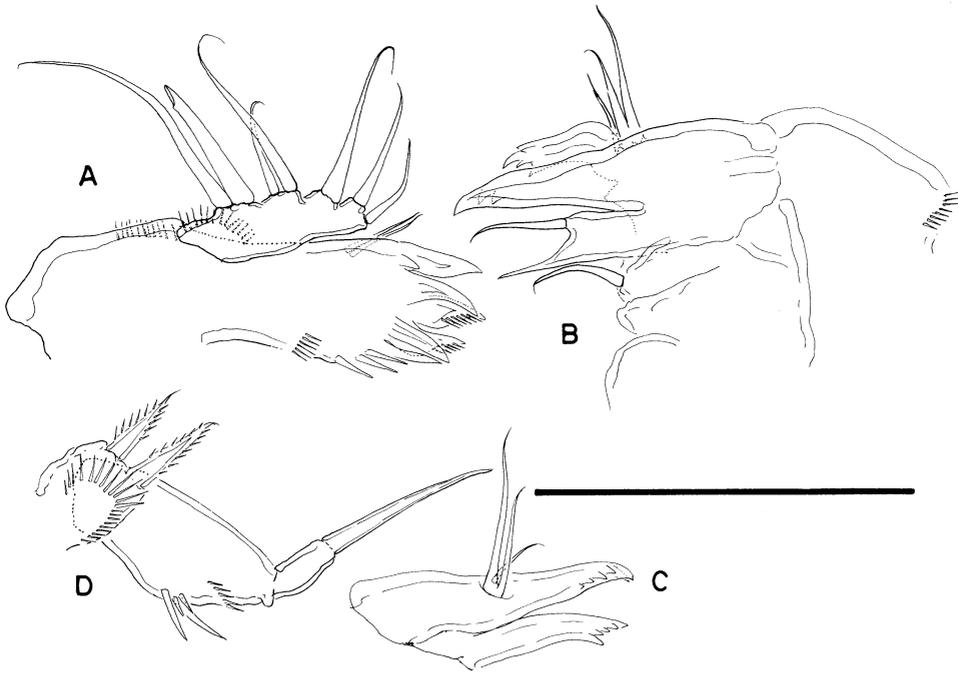


Figure 3. *Kristensenia secunda* Gómez sp. nov., female. (A) Maxillule; (B) maxilla; (C) basis of maxilla showing endopod; (D) maxilliped. Scale bar: 50  $\mu$ m.

Cephalothorax about one-sixth total length. Total body length ranging from 680 to 950  $\mu$ m measured from tip of rostrum to posterior margin of caudal rami. Rostrum (Figure 2A) distinct, with pointed tip, with pair of subapical sensillae. Dorsal and ventral surface of free thoracic somites and urosome (not shown), smooth. Second and third urosomites distinct dorsally and ventrally; genital pore (not shown) located rather proximally on second urosomite. Anal somite nearly as long as fourth and fifth urosomites combined; with semi-circular anal operculum dorsally, the latter ornamented with small spinules along posterior margin and flanked by two sensillae. Caudal rami (Figure 1C, D) with straight and concave outer and inner margin, respectively; broader at its base and about 1.8 times longer than broad; with seven elements in all; insertion site of seta VII located on inner distal corner.

Antennule (Figure 2A) six-segmented; with bare and slender setae only; with aesthetasc on fourth segment. Armature formula as follows: I-(1); II-(11); III-(9); IV-(3 + ae); V-(2); VI-(15). With two distal setae of sixth segment fused at base.

Antenna (Figure 2B) with allobasis; the latter ornamented with two transverse rows of spinules on inner margin. Exopod one-segmented; with one pinnate, well-developed element. Endopodal segment ornamented with strong spinules proximally and distally; with eight elements in all (two lateral spines and one slender and small seta, and five apical spines); with serrate hyaline frill on outer distal corner.

Mandible (Figure 2C) with sclerotized gnathobase; biting edge with four teeth and some spinules apically, and with one bipinnate dorsal seta. With clear division between basis and endopod; the former with one strong seta; the latter with one lateral and three apical elements.

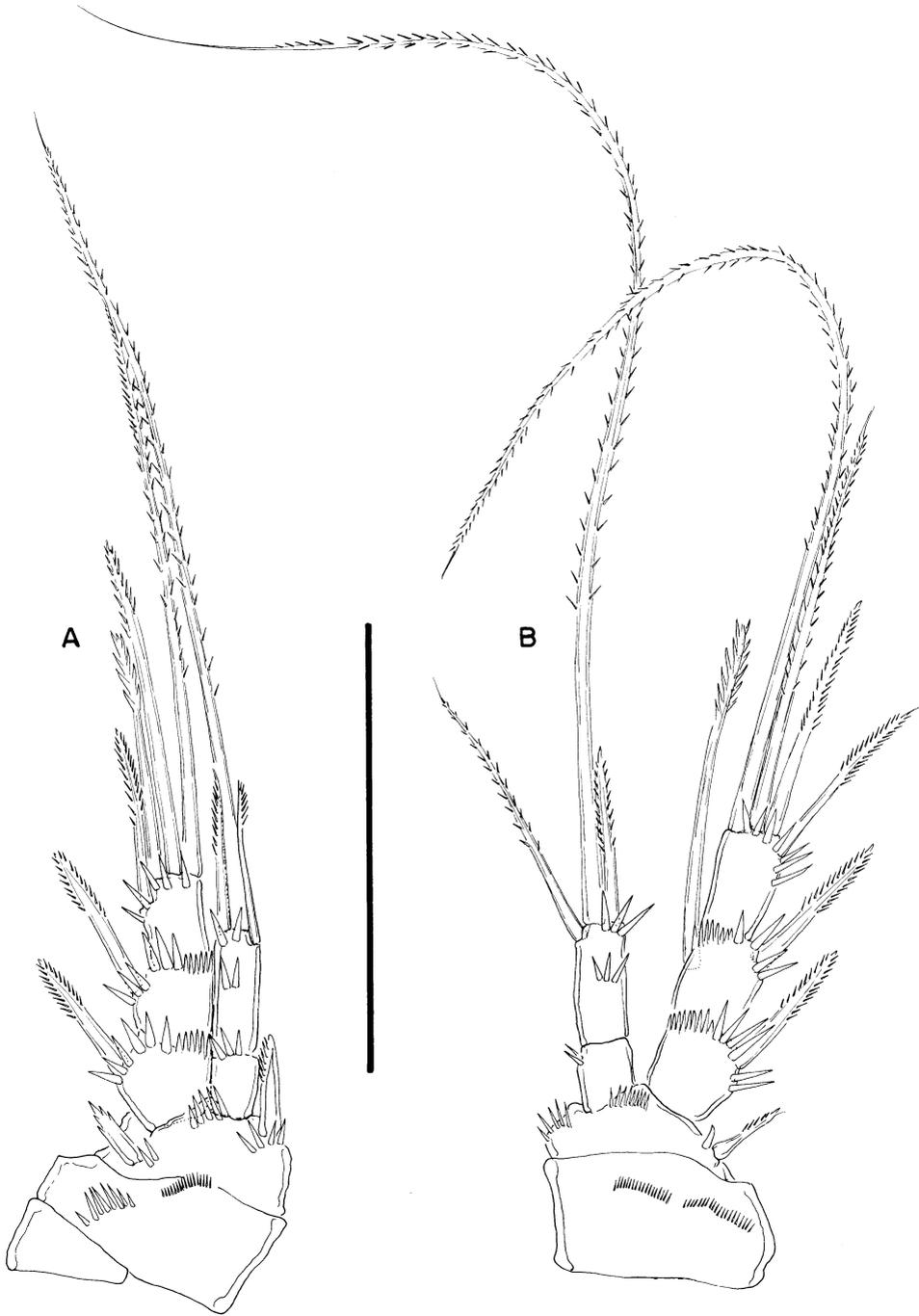


Figure 4. *Kristensenia secunda* Gómez sp. nov., female. (A) P1; (B) P2. Scale bar: 100  $\mu$ m.

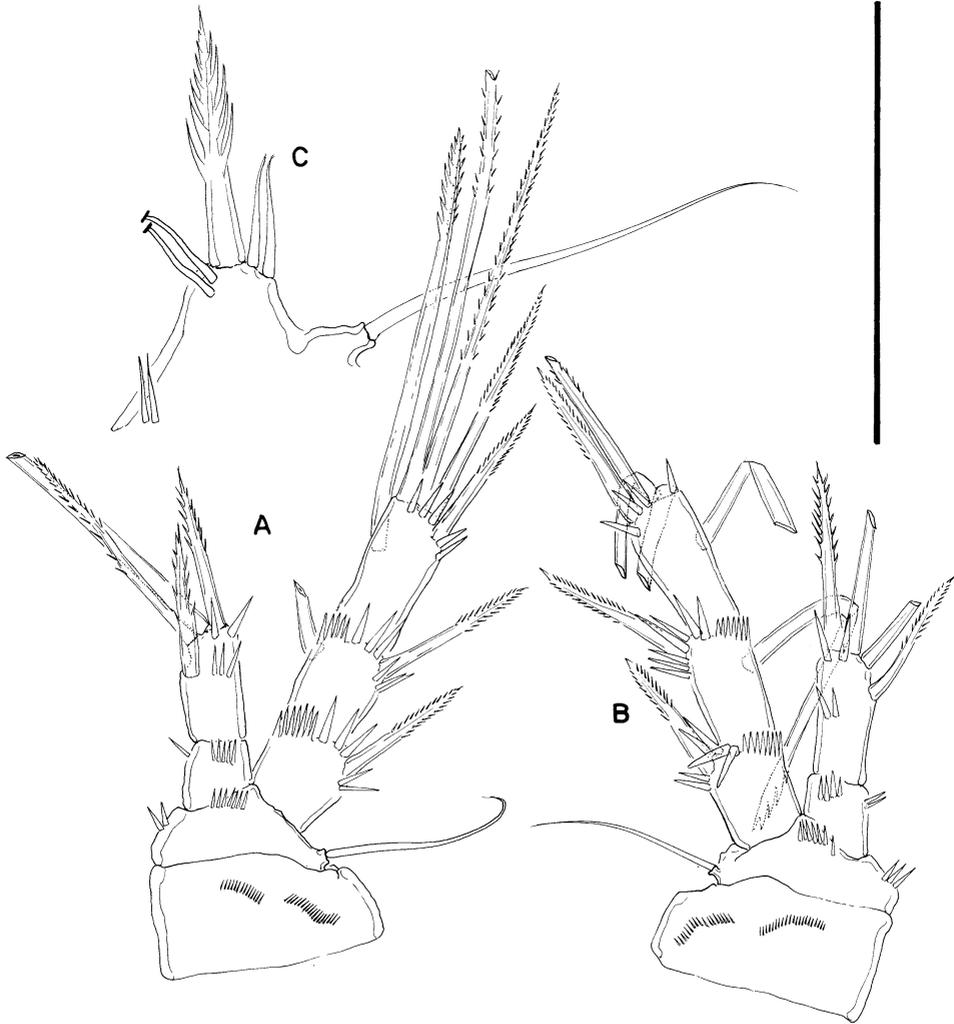


Figure 5. *Kristensenia secunda* Gómez sp. nov., female. (A) P3; (B) P4; (C) P5. Scale bar: 100  $\mu$ m (A, B); 60  $\mu$ m (C).

Maxillule (Figure 3A): arthrite of praecoxa with four bare teeth and two ornamented with spinules apically, three strong spinules distally and a short transverse row of smaller spinules laterally; with two short surface setae. Without division between basis, endo- and exopod; basis with three setae, endopod and exopod with two setae each.

Maxilla (Figure 3B, C) with robust syncoxa ornamented with outer, short and transverse spinular row; with two endites; proximal endite with one seta; distal endite with two elements (one of which seems to be fused to the endite). Basis as illustrated (Figure 3B, C). Endopod represented by three setae (two of them fused) (Figure 3B, C).

Maxilliped (Figure 3D) subchelate; syncoxa ornamented with spinules and armed with two strong bipinnate setae; basis without armature and ornamented with outer spinules; with elongate endopodal segment armed with claw.

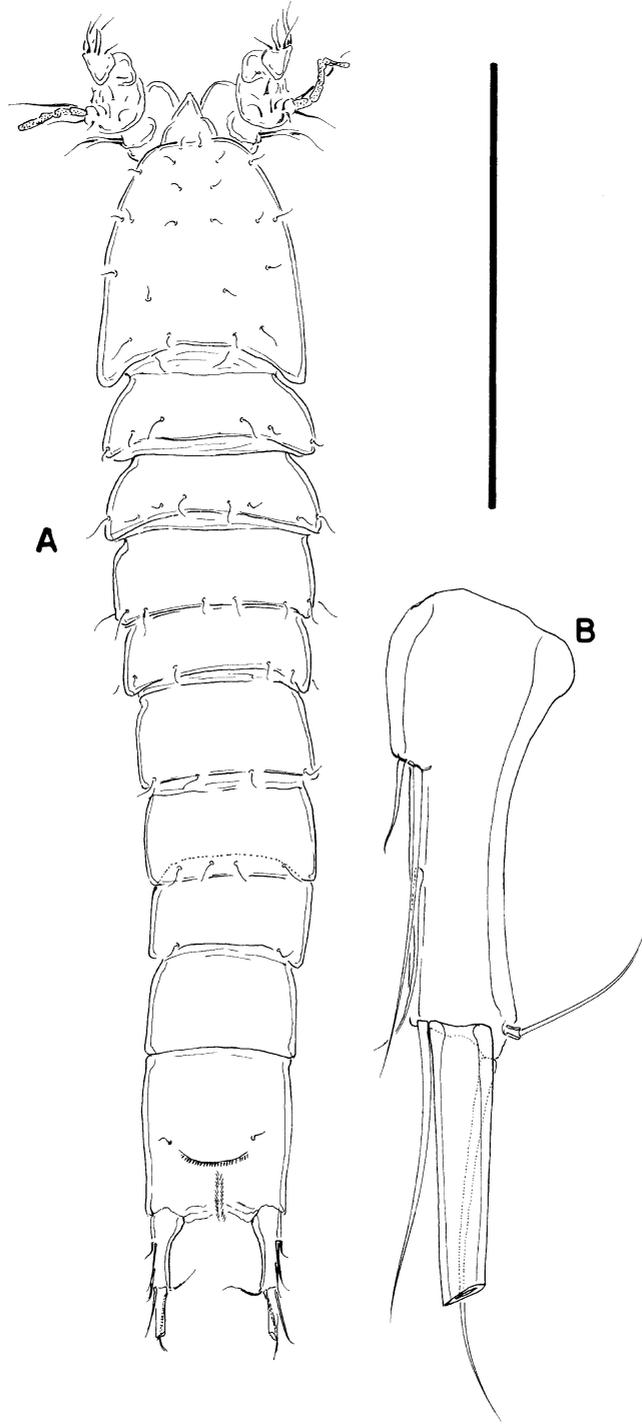


Figure 6. *Kristensenia secunda* Gómez sp. nov., male. (A) Habitus, dorsal; (B) left caudal ramus, dorsal. Scale bar: 286  $\mu\text{m}$  (A); 50  $\mu\text{m}$  (B).

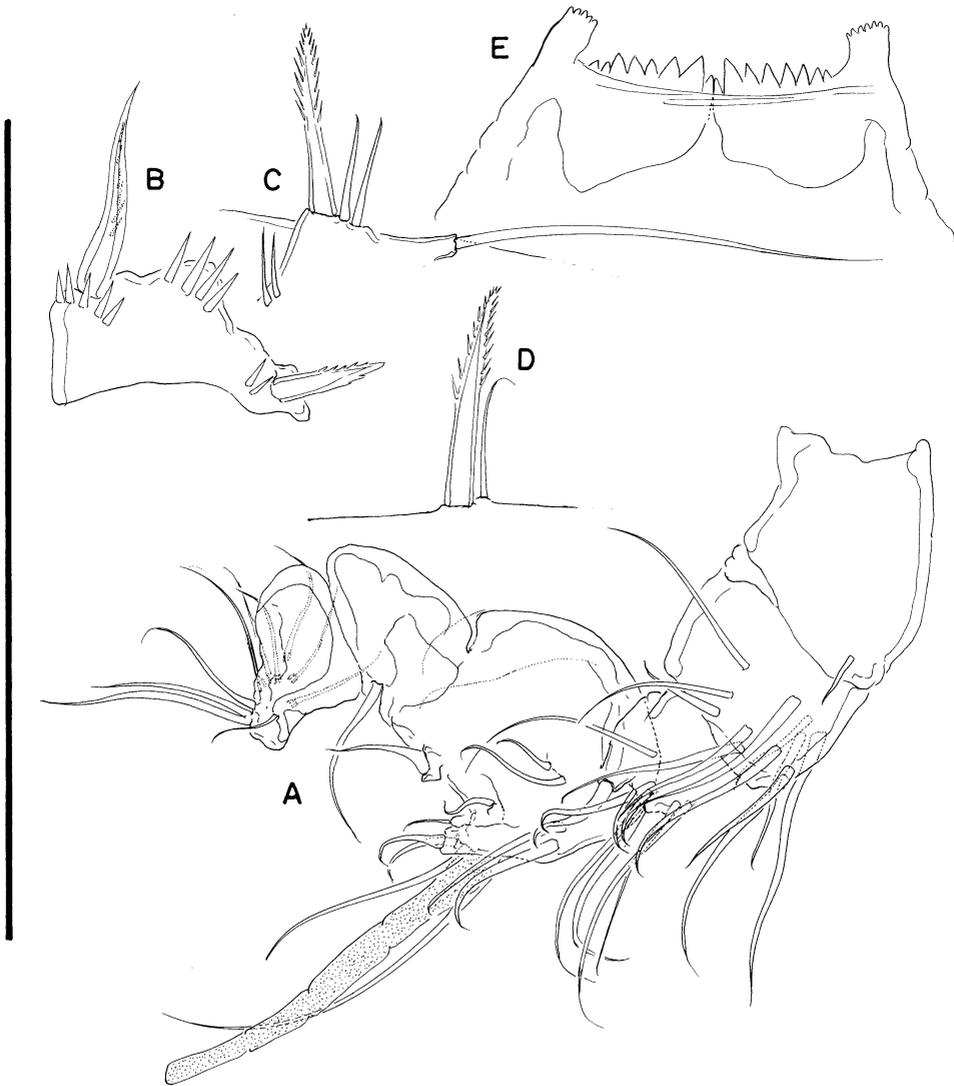


Figure 7. *Kristensenia secunda* Gómez sp. nov., male. (A) Antennule; (B) basis of P1; (C) P5; (D) P6; (E) labrum. Scale bar: 143  $\mu$ m (A); 100  $\mu$ m (B–E).

Labrum (not shown) as in male (Figure 7E).

P1 (Figure 4A): coxa ornamented with two median rows of spinules. Basis ornamented with spinules between rami and at base of outer and inner spine. Exopod three-segmented. Endopod two-segmented.

P2–P4 (Figures 4B, 5A, B): coxa as in P1. Basis with spinules between rami and close to inner distal corner; of P2 with outer spine; of P3 and P4 with outer slender and bare seta. Exopod three-segmented; second segment with inner seta; third segment of P2 without, of P3 and P4 with inner seta. Endopod two-segmented; of P2 without, of P3 and P4 with inner element. Armature formula of P1–P4 as in Table I.

Table I. Armature formula of *Kristensenia secunda* Gómez sp. nov.

	P1	P2	P3	P4
EXP	I-0; I-0; II, 2, 0	I-0; I-1; II, 2, 0	I-0; I-1; II, 2, 1	I-0; I-1; II, 2, 1
ENP	0-0; I, II, 0	0-0; I, 2, 0	0-0; I, 2, I	0-0; I, 2, I

P5 (Figure 5C) seemingly without exopod. With triangular baseo-endopod armed with two outer and two inner distal slender and bare setae, one strong bipinnate spine apically and two innermost slender setae.

*Male.* Body (Figure 6A) as in female. Total body length ranging from 670 to 680  $\mu\text{m}$ . Caudal rami as in female, except for some slight sexual dimorphism, being the inner lateral contour of the male caudal ramus more even than that of the female.

Antennule (Figure 7A) six-segmented, subchirocer; with geniculation between third and fourth segments; fourth segment swollen. Armature formula difficult to define, seemingly I-(1); II-(12); III-(8); IV-(11 + ae); V-(1); VI-(10).

P1 as in female except for dimorphic inner spine of basis (Figure 7B). P2–P4 (not shown) as in female.

P5 (Figure 7C) with two slender and bare outer setae, one strong and bipinnate apical spine, and two innermost slender and bare setae.

P6 (Figure 7D) with one outer slender seta and one inner strong and bipinnate spine.

#### *Taxonomic remarks*

The genus *Kristensenia* was created by Por (1983) to accommodate one adult male and three immature females of *K. pallida*. It has to be noted that Por (1983: 147, Figures 34–41) inadvertently mistook P2 for P3, and that his armature formula for the endopod of P3 (1983: 145) should read 0.220 instead of 0.221. The original description of the species was based on a single male, and probably based on the above mistake, Por (1983: 145) suggested that if some sexual dimorphism exists, it could consist of a ‘rich armature of P3 endopodite’. In fact, sexual dimorphism was only observed in the male antennule, P5 and P6, and male caudal ramus for *K. secunda* sp. nov., whereas the armature/ornamentation of male and female P2–P4 are identical. In his description, Por (1983) included a brief description of what he thought should be an immature female (probably a fifth copepodid), based on the general shape of the swimming legs. Notably, Por (1983) remarked that the female P5 possessed ‘one apical seta and two weaker internal setae; also an internal-basal seta’. In this regard, it has to be noted that Por’s (1983) two inner setae are actually two outer setae, and the internal basal seta is the outer basal seta. As Por (1983) indicated, the females of *K. pallida* were immature individuals, which can be confirmed by comparison of the general shape of the outer exopodal spines of P4. The immature females of *K. pallida* were also described as possessing two outer setae on P5, which seems to be the copepodid condition as evidenced by adult females of *K. secunda* sp. nov., which exhibit two inner and two innermost setae, and two outer setae on P5. The male caudal rami of *K. pallida* were described as possessing five setae only. It is our opinion that Por (1983), based on his ventral view of the ramus, overlooked seta II which lies dorsal to seta I, and seta III which arises on distal third laterally in *K. secunda* sp. nov. Also, the male P5 of *K. pallida* possesses one apical and two outer setae as described by Por (1983). The new Mexican species

possesses two inner, one apical and two outer setae on the male P5. Unfortunately Por's (1983) material of *K. pallida* seems to be unavailable (Dr M. Nechama Ben-Eliahu, Curator Emeritus, Section of Invertebrates, The Hebrew University of Jerusalem, personal communication) and comparisons could not be made regarding the above appendages. Based on Por's (1983) description, the following differences were found between *K. pallida* and *K. secunda* sp. nov.: (1) armature formula of mandibular endopod (with two lateral setae in *K. pallida*; with one lateral seta in *K. secunda* sp. nov.). In this regard it has to be noted that Por (1983) described the mandible as possessing a small exopod. This is obviously a misinterpretation and the supposed small exopod is the swollen proximal part of the basal seta. Also, in his figure, Por (1983: 146, Figure 29) shows two lateral setae on the mandibular palp, whereas in his microphotograph (Por 1983: 151, Figure 70) only one seta appears, which, according to *K. secunda* sp. nov., seems to be the correct condition; (2) armature formula of maxillular basis (with four setae in *K. pallida*; with three setae in *K. secunda* sp. nov.); (3) even though Por (1983) described the maxilliped of *K. pallida* from an immature female (the male maxilliped was not found), it has to be noted that Por (1983) showed two outer, slender basal setae, which are spinule-like in *K. secunda* sp. nov.; (4) shape and relative length of apical element of both female and male P5, which is seta-like, barely ornamented with small spinules or setules, and about three times as long as adjacent setae in *K. pallida* (see Por 1983: 147, Figure 40), but spine-like, strongly spinulose and about twice as long as adjacent setae in *K. secunda* sp. nov. Por's (1983) type material of *K. pallida* is not available and the only extant material is that reported by Fiers (1995). This species needs to be redescribed in detail to solve a number of uncertainties in Por's (1983) original description and to allow a more objective judgement on the specificity of the Sinaloa material. Unfortunately, we were unable to borrow the Mexican material of the species and its redescription is still pending.

**Order CYCLOPOIDA** Burmeister, 1834  
**Family CYCLOPIDAE** Dana, 1846  
**Subfamily HALICYCLOPINAE** Kiefer, 1927  
**Genus *Halicyclops*** A. M. Norman, 1903  
*Halicyclops hurlberti* Rocha, 1991  
 (Figures 8–14)

*Distribution.* USA: Tihuana estuary, California (Rocha 1991); Mexico: Sinaloa, north-western Mexico (present study).

*Citations.* Rocha (1991).

*Taxonomic remarks*

In the original description of *H. hurlberti*, Rocha (1991) allocated the species to a group defined by the ornamentation of seta V of the caudal rami, size of the female fourth antennular segment and size of the inner spine of the basis of P1. On the other hand, Rocha (1991) defined *H. hurlberti* by the size and shape of the inner distal seta of P4 endopod 3, shape and size of the P5 exopod, and relative length and separation between the setae of the same leg. The specimens found in sediment samples from Ensenada del Pabellón lagoon and Urías system are identical to *H. hurlberti* as described by Rocha (1991) based on the characteristics listed above (Figures 8A–C, 11A, B, 12A, B, 13A, B). In the original

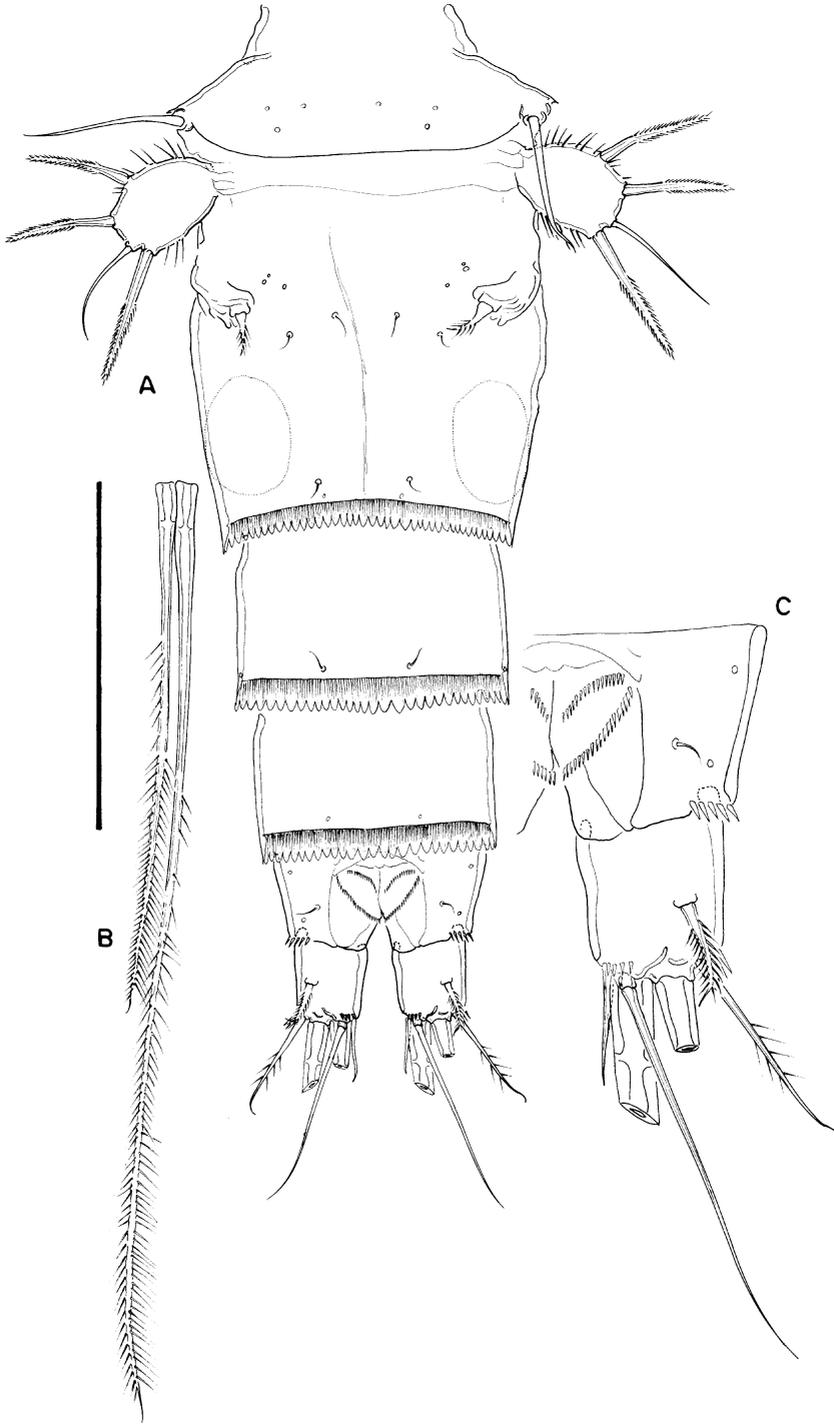


Figure 8. *Halicyclops hurlberti* Rocha 1991, female. (A) Urosome, dorsal; (B) caudal setae IV and V; (C) anal somite and right caudal ramus, dorsal. Scale bar: 100 µm (A); 143 µm (B); 50 µm (C).

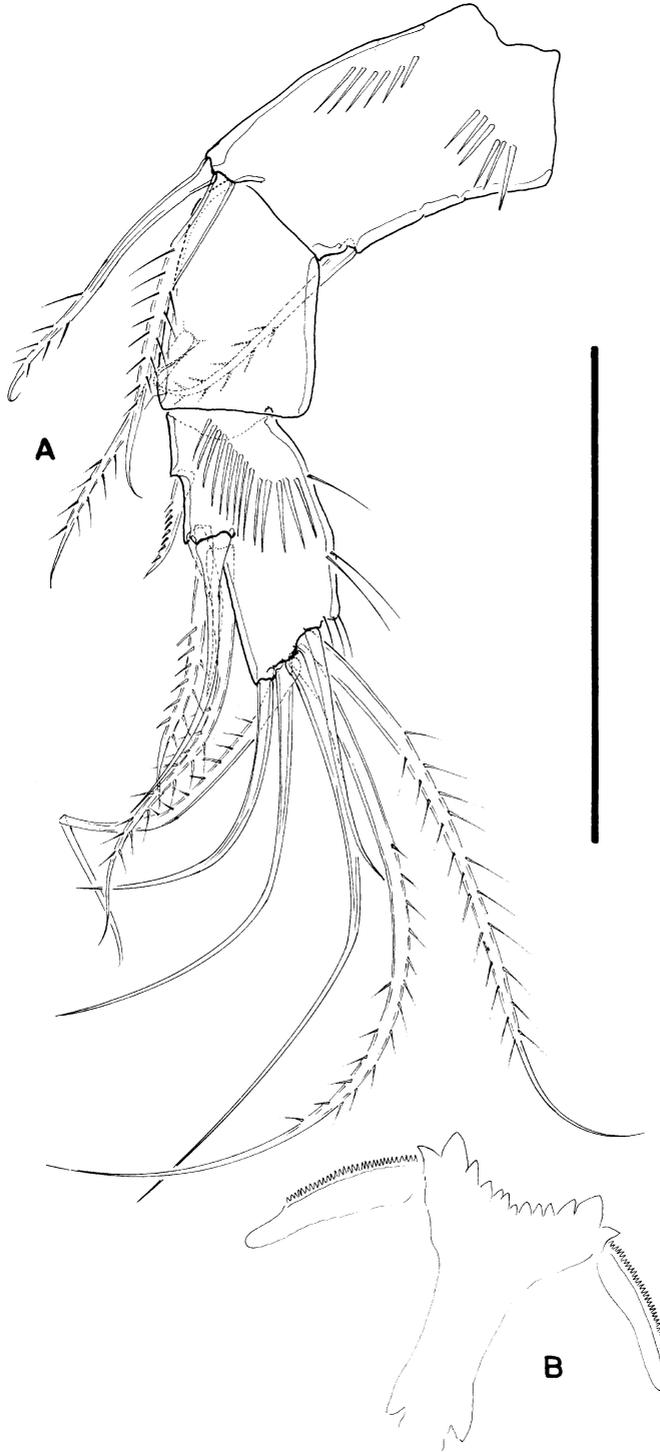


Figure 9. *Halicyclops hurlberti* Rocha 1991, female. (A) Antenna; (B) labrum. Scale bar: 60  $\mu\text{m}$ .

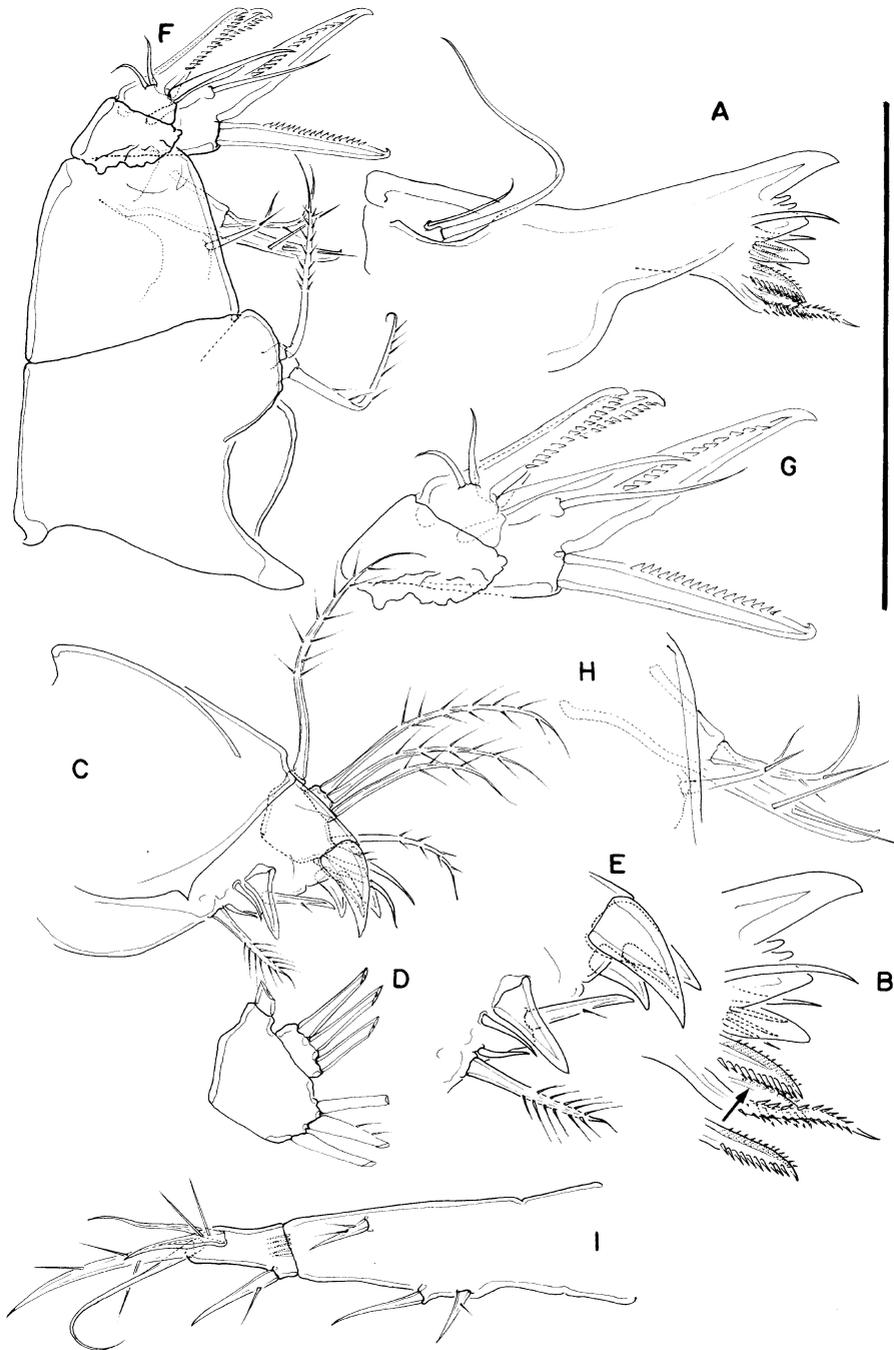


Figure 10. *Halicyclops hurlberti* Rocha 1991, female. (A) Mandible; (B) biting edge of mandibular gnathobase; (C) maxillule; (D) maxillulary palp showing armature of basis, endopod and exopod; (E) arthrite of maxillulary praecoxa; (F) maxilla; (G) maxillary allobasis and endopod; (H) maxillary coxal endite; (I) maxilliped. Scale bar: 70  $\mu$ m (A, I); 47  $\mu$ m (B); 100  $\mu$ m (C, F); 67  $\mu$ m (D, E, G, H).

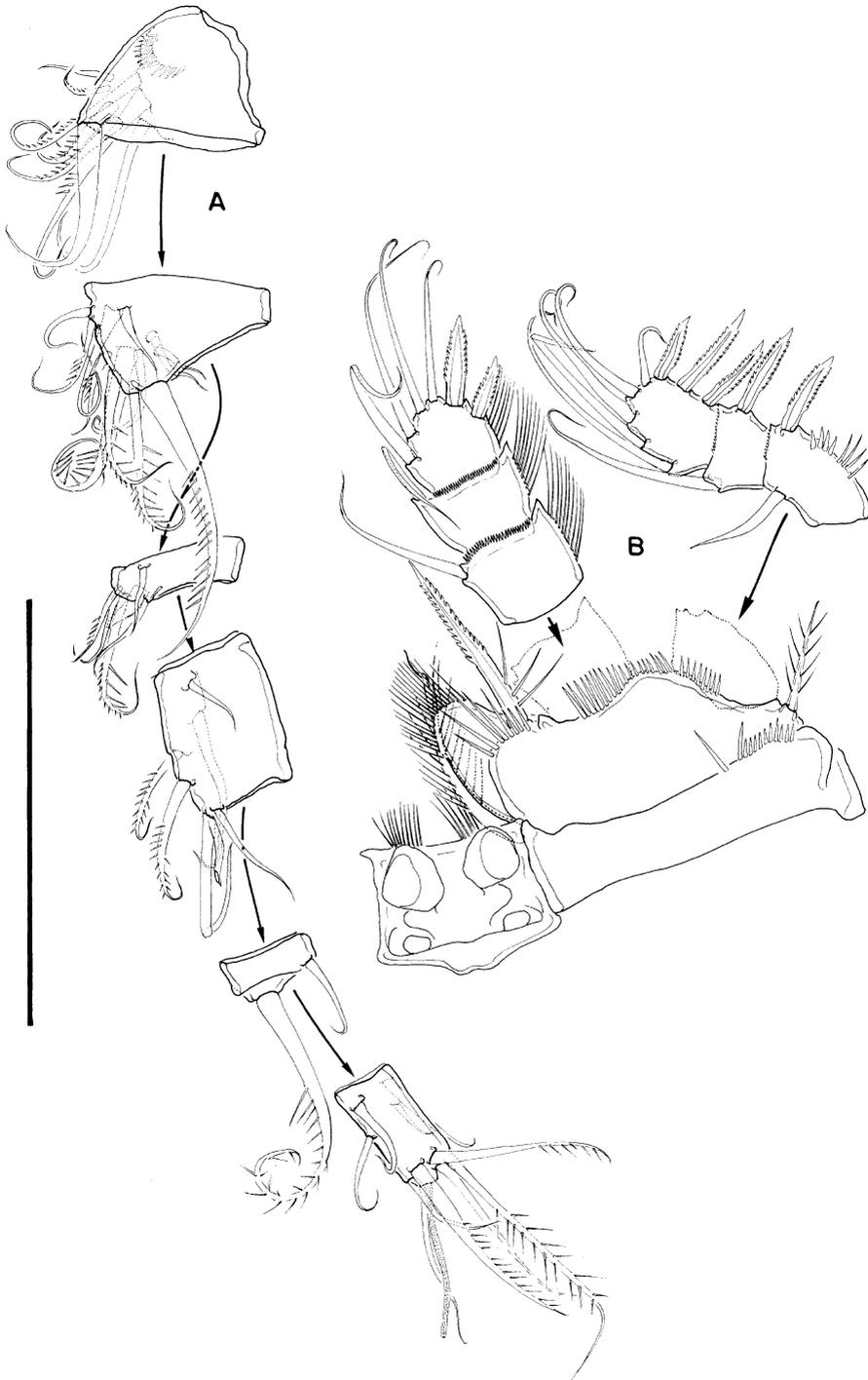


Figure 11. *Halicyclops hurlberti* Rocha 1991, female. (A) Antennule, disarticulated; (B) P1. Scale bar: 100  $\mu$ m.

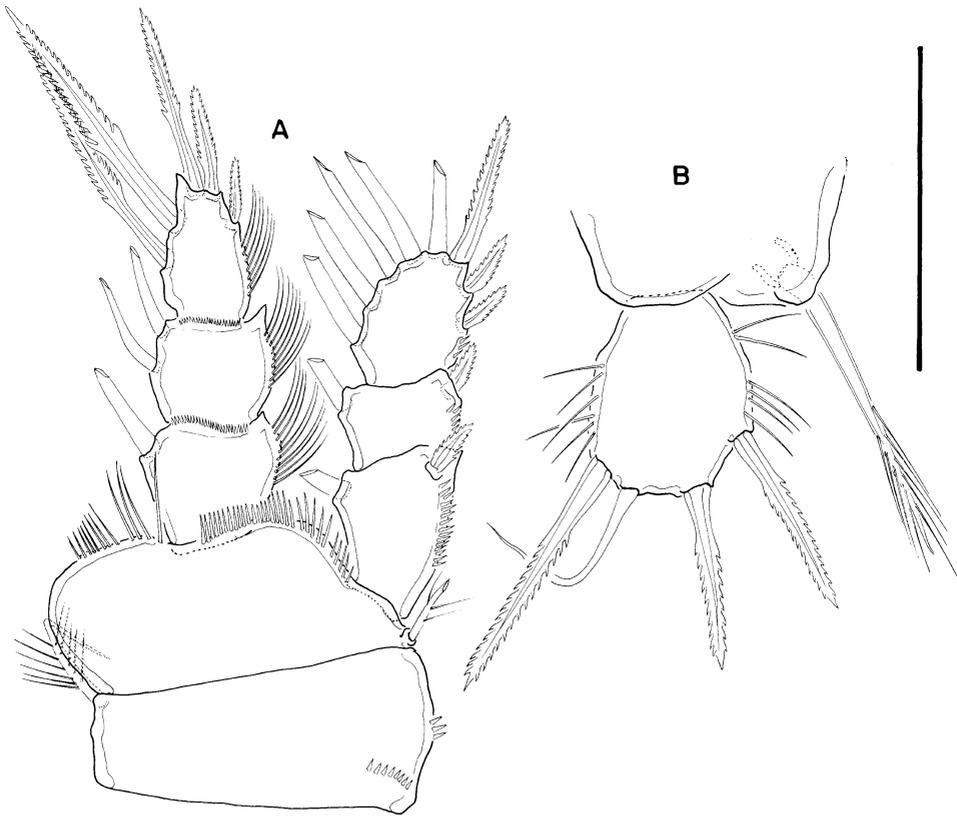


Figure 12. *Halicyclops hurlberti* Rocha 1991, female. (A) P4; (B) P5. Scale bar: 71  $\mu\text{m}$  (A); 50  $\mu\text{m}$  (B).

description, Rocha (1991) gave only the armature formula of the female antennule and omitted the description of mouthparts since they are 'as those of *Halicyclops glaber* Rocha 1983'. We include the complete illustration of female A1 (Figure 11A), A2 (Figure 9A), Md, Mxl, Mx, Mxp (Figure 10A–I) and labrum (Figure 9B), as well as of male A1 (Figure 14), P5, P6 and abdomen (Figure 13A, B). This new record extends the distribution of the species from temperate southern California to the subtropical eastern Pacific.

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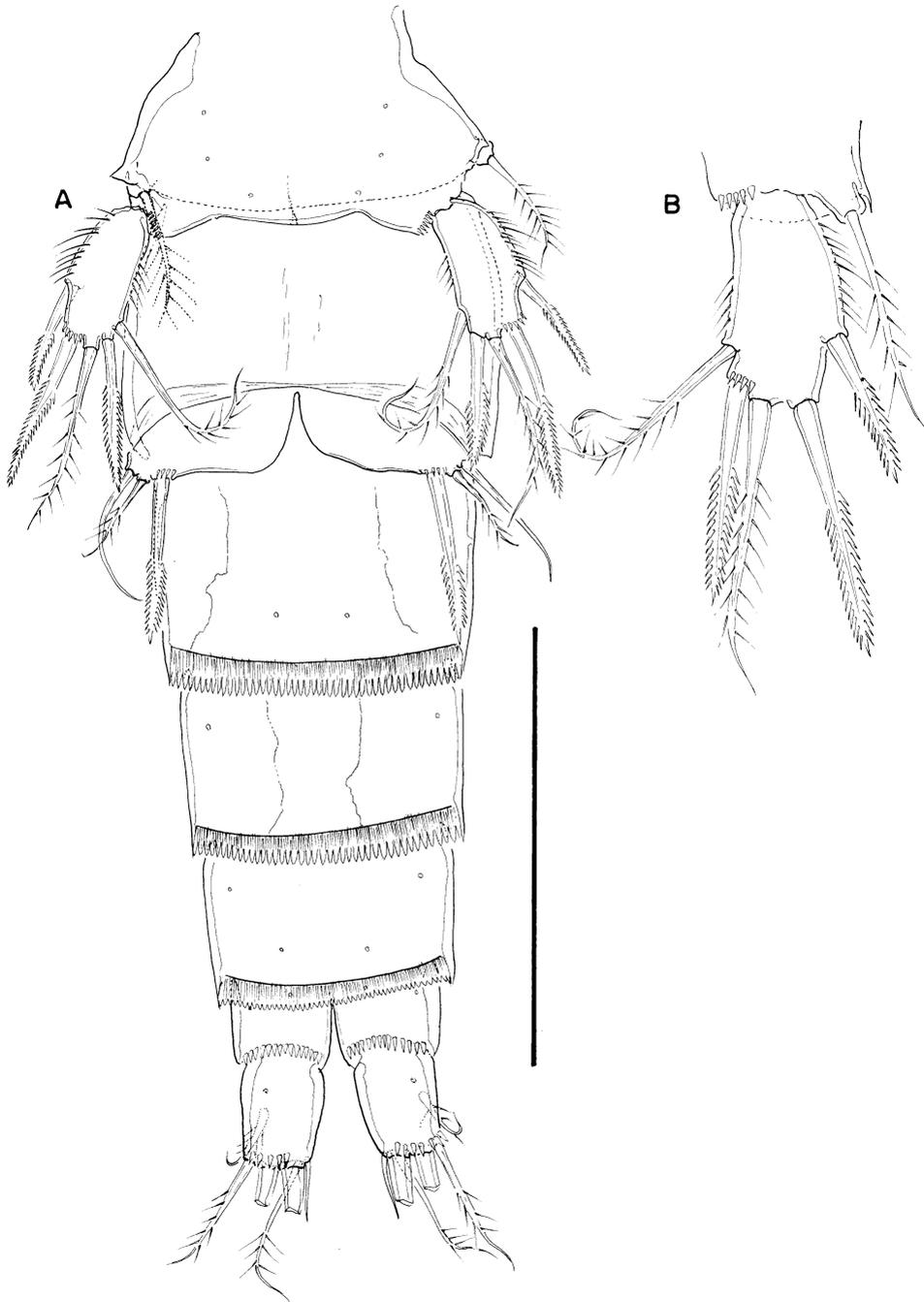


Figure 13. *Halicyclops hurlberti* Rocha 1991, male. (A) Urosome, ventral; (B) P5. Scale bar: 100  $\mu\text{m}$  (A); 60  $\mu\text{m}$  (B).

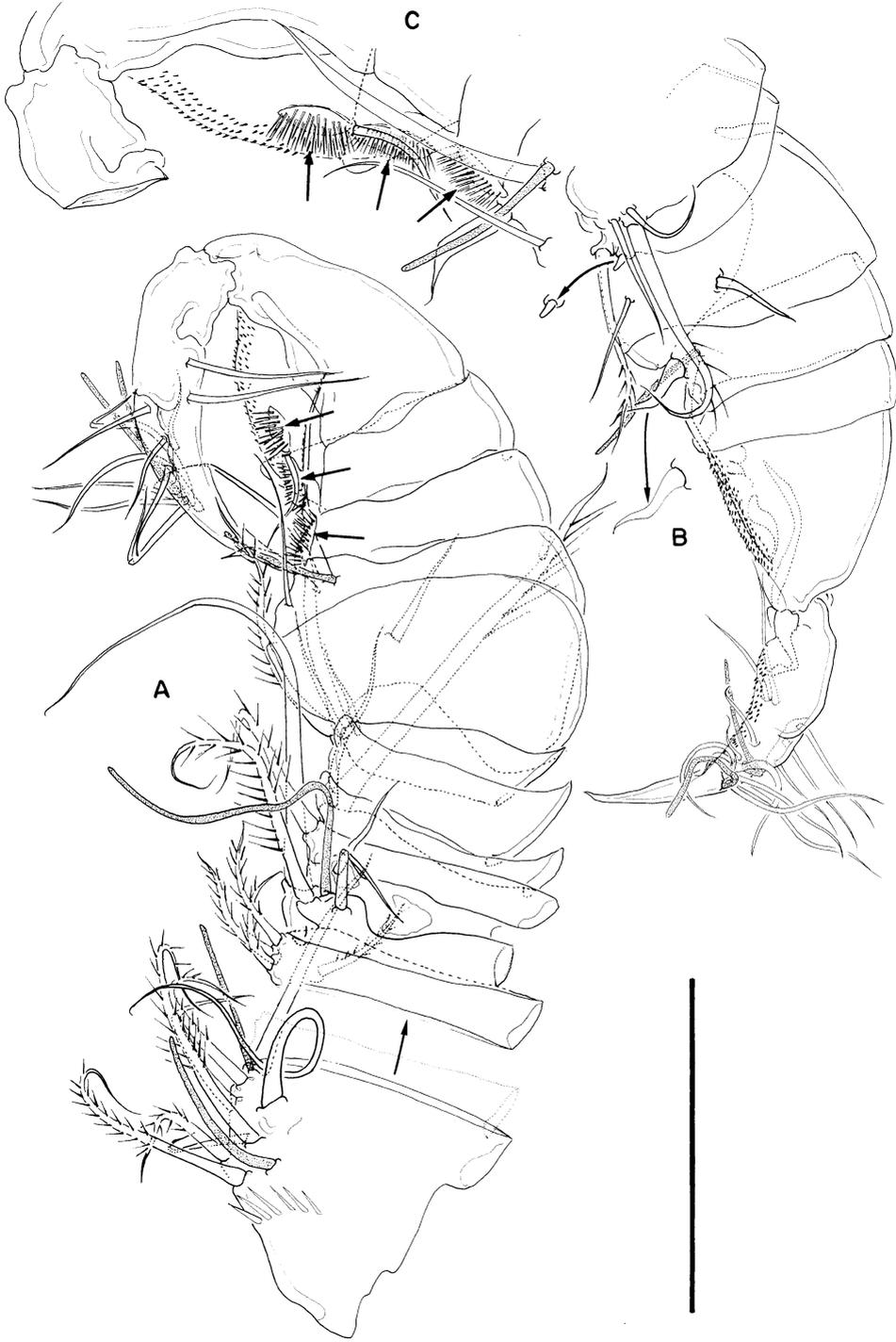


Figure 14. *Halicyclops hurlberti* Rocha 1991, male. (A) Antennule; (B) segment VI–XII of A1; (C) segment XI–XII of A1. Scale bar: 50  $\mu\text{m}$  (A); 63  $\mu\text{m}$  (B); 33  $\mu\text{m}$  (C).

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